

CLAIMS

1. A method for producing upgraded coal for metallurgy by extracting coal with an organic solvent, the method comprising:

a slurry preparing step of mixing the coal and the organic solvent to prepare a raw material slurry;

an extraction step of aging the raw material slurry by heating to extract a soluble component of the coal in the organic solvent to prepare an extracted slurry; and

a solvent removing step of removing the organic solvent from the extracted slurry by evaporation to produce upgraded coal for metallurgy as a solid form.

2. The method according to claim 1, wherein the solvent removing step comprises:

a sedimentation step of sedimenting an insoluble component of the coal by allowing the extracted slurry to stand to separate between a supernatant containing an extracted coal, which is the extracted soluble component, and a residual coal slurry containing a residual coal, which is the sedimented insoluble component; and

a first solvent removing step of removing the organic solvent from the supernatant by evaporation to produce the extracted coal as the upgraded coal for metallurgy.

3. The method according to claim 1, wherein the solvent removing step comprises:

a sedimentation step of sedimenting an insoluble component of the coal by allowing the extracted slurry to stand to separate between a supernatant containing an extracted coal, which is the extracted soluble component, and a residual coal slurry containing a residual coal, which is the sedimented insoluble component;

a first solvent removing step of removing the organic solvent from the supernatant by evaporation to produce the extracted coal as a solid form; and

a second solvent removing step of removing the organic solvent from the residual coal slurry by evaporation to produce the residual coal as a solid form.

4. The method according to claim 3 further comprising:

a compounding step of compounding the extracted coal and the residual coal to produce the upgraded coal for metallurgy having controlled thermal plasticity.

5. The method according to claim 4, wherein the compounding ratio of the residual coal to the upgraded coal for metallurgy is over 0% by mass and 70% by mass or less.

6. The method according to claim 1, wherein in the

extraction step, the heating temperature is 250°C to 400°C.

7. The method according to claim 1, wherein in the extraction step, the aging time is 5 to 120 minutes.

8. The method according to claim 1, wherein in the extraction step, aging is performed in a nitrogen atmosphere at 0.5 MPa or more.

9. The method according to claim 1, wherein the organic solvent contains a two ring aromatic compound as a main component and has a boiling point of 200°C to 300°C at normal pressure.

10. This method according to claim 1 further comprising a solvent recovering step of recovering the organic solvent removed by evaporation and recycling the solvent to the slurry preparing step.

11. The method according to claim 1, wherein the recovered organic solvent is not rehydrogenated.

12. The method according to claim 10, wherein means for recovering the organic solvent comprises vacuum distillation or spray drying.

13. Upgraded coal for metallurgy produced by the method according to claim 1.

14. A method for producing a reduced metal using upgraded coal for metallurgy produced by extracting coal with an organic solvent, the method comprising:

a coal upgrading step of aging the coal by heating in the organic solvent to produce the upgraded coal for metallurgy having higher thermal plasticity than that of the coal;

a mixing step of mixing the upgraded coal for metallurgy and a metal oxide raw material containing a metal oxide to prepare a mixture; and

a reduction step of reducing the mixture by heating in a moving hearth furnace to produce a reduced metal as a reduced mixture.

15. The method according to claim 14 further comprising:

a step of successively heating the reduced mixture in the moving hearth furnace to coagulate the reduced metal in the reduced mixture.

16. The method according to claim 14 further comprising:

a melting step of melting the reduced mixture by

heating in a melting furnace to separate between a metal and a slag; and

a recovering step of discharging the metal to the outside of the furnace and recovering the metal as the reduced metal.

17. The method according to claim 14 further comprising:

a reduction and melting step of reducing the mixture by heating in the moving hearth furnace to produce a reduced mixture, and then melting the reduced mixture by further heating to produce the reduced metal.

18. The method according to claim 14 further comprising:

a reduction and melting step of reducing the mixture by heating in the moving hearth furnace to produce a reduced mixture, and then melting the reduced mixture by further heating to produce the reduced metal;

a solidification step of solidifying the reduced metal by cooling in the moving hearth furnace to produce a reduced solid; and

a separation and recovery step of discharging the reduced solid to the outside of the furnace to separate between a metal and a slag and recover the metal as the reduced metal.

19. A method for producing a slag containing an oxidized nonferrous metal using upgraded coal for metallurgy, which is produced by extracting coal with an organic solvent, the method comprising:

a coal upgrading step of aging the coal by heating in the organic solvent to produce upgraded coal for metallurgy which has higher thermal plasticity than that of the coal;

a mixing step of mixing the upgraded coal for metallurgy and a metal oxide-containing raw material containing iron oxide and an oxidized nonferrous metal to prepare a mixture;

a reduction and melting step of reducing the iron oxide in the mixture by heating the mixture in a moving hearth furnace to produce a reduced mixture containing metallic iron, and then melting the metallic iron by heating the reduced mixture to separate between the metallic iron and an oxidized nonferrous metal slag;

a solidification step of solidifying the metallic iron in the mixture containing the oxidized nonferrous metal slag and the melted metallic iron by cooling in the moving hearth furnace to produce a reduced solid; and

a separation and recovery step of discharging the reduced solid to the outside of the furnace to separate between the metal and the slag and recover the slag as the oxidized nonferrous metal slag.

20. A reduced metal produced by the method according to claim 14.

21. A slag containing an oxidized nonferrous metal produced by the method according to claim 19.